PATENT SPECIFICATION

(11) 1 531 406

(21) Application No. 34763/77 (22) Filed 18 Aug. 1977 (19)
(31) Convention Application No. 2637338
(32) Filed 19 Aug. 1976 in
(33) Fed. Rep of Germany (DE)
(44) Complete Specification published 8 Nov. 1978
(51) INT. CL.[2] H01K 1/58
(52) Index at acceptance
H1F 2A1F2 2A1G2 2D10 2N4 2X

1 531 406

(54) IMPROVEMENTS IN OR RELATING TO INFRARED RADIATING MEMBERS

(71) We, HERAEUS QUARZSCHMELZE GMBH, a German Body Corporate, of Quarzstrasse, 6450 Hanau/Main, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to coolable infrared radiating members made of transparent, opaque or opalescent fused silica which has an electrical heat-generating filament as a radiation source, and a cooling tube through which a coolant flows. Hereinafter such a member will be referred to as "of the kind described".

A coolable infrared lamp is disclosed in U.S patent 3,240,115 wherein the reflector part which holds the infrared lamp is provided with cooling passages. Although this ensures good cooling of the reflector part, it provides no cooling or only slight cooling for the infrared lamp itself.

Coolable infrared radiating members are disclosed in German Offenlegungsschrift No. 1,960,875. The radiation source which comprises the electrical filament is concentrically enclosed by a tube of transparent fused silica. For cooling, a cooling medium can be passed through the tube of transparent fused silica, thus preventing the tube from heating up to more than 140°C. The silica tube enclosing the radiation source may also be of double-walled design so that the cooling medium only flows between the two walls of the tube. It is true that a design such as this for an infrared lamp provides good cooling for the radiation source, which allows quite a high level of electrical power to be applied to the filament. However, because the radiation, on its path from the filament to an object to be irradiated, before reaching the object must always pass through the jacket of cooling medium, which acts as a filter, there is a not inconsiderable attenuation of the radiation.

It is an object of the invention to provide an infrared radiating member which is of simple construction, which can be produced in an economical fashion, which forms an easily exchanged component, and which allows a high level of electrical power to be applied to the heat-generating filament as a result of being vigorously cooled.

Accordingly the invention consists in a coolable infrared radiating member of the kind described wherein between 10% and 90% of the area of the wall of the tubular envelope for the filament is at the same time a part of the wall area of the cooling tube, and the cooling tube at no place completely surrounds the radiation source.

Advantageously, 25% to 75% of the area of the wall of the tubular envelope for the filament is at the same time a part of the wall of the cooling tube. By closing off one end of the cooling tube and inserting a means for dividing the stream of coolant, in the form of a plate or a tube for example, it is possible to arrange for the infeed and outfeed of coolant to take place at only one end of the infrared radiating member. Similarly, by for example inserting a plate or a tube in the tubular envelope for the filament, it is also possible to arrange the conductor in its tubular envelope in such a way that the electrical terminals are situated at only one end of the infrared radiating member. When the infrared radiating member is formed in this manner, namely with the coolant fed in and out at only one end of the cooling tube and the electrical terminals for the filament situated at only one end of the tubular envelope for the filament, then advantageously the infeed and outfeed of coolant is caused to take place at one end of the infrared radiating member and the electrical terminals for the filament are located at the opposite end. This physical separation between the electrical connecting area and the coolant infeed and outfeed area provides a high degree of safety in the operation of the infrared radiating member. To generate directional infrared radiation, it has proved advantageous to provide an appropriate part of the wall of the infrared radiating member with a reflective layer and preferably to gild it.

Infrared radiating members according to the invention can be used in many different applications. For example they may be fitted to copying apparatus, to devices for welding webs of plastics materials, in materials testing apparatus, and in installations for drying

PATENT SPECIFICATION (11) 1 531 406

1 531 406

(21) Application No. 34763/77 (22) Filed 18 Aug. 1977 (19)
(31) Convention Application No. 2637338
(32) Filed 19 Aug. 1976 in
(33) Fed. Rep of Germany (DE)
(44) Complete Specification published 8 Nov. 1978
(51) INT. CL.[2] H01K 1/58
(52) Index at acceptance
H1F 2A1F2 2A1G2 2D10 2N4 2X

(54) IMPROVEMENTS IN OR RELATING TO INFRARED RADIATING MEMBERS

(71) We, HERAEUS QUARZSCHMELZE GMBH, a German Body Corporate, of Quarzstrasse, 6450 Hanau/Main, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to coolable infrared radiating members made of transparent, opaque or opalescent fused silica which has an electrical heat-generating filament as a radiation source, and a cooling tube through which a coolant flows. Hereinafter such a member will be referred to as "of the kind described".

A coolable infrared lamp is disclosed in U.S patent 3,240,115 wherein the reflector part which holds the infrared lamp is provided with cooling passages. Although this ensures good cooling of the reflector part, it provides no cooling or only slight cooling for the infrared lamp itself.

Coolable infrared radiating members are disclosed in German Offenlegungsschrift No. 1,960,875. The radiation source which comprises the electrical filament is concentrically enclosed by a tube of transparent fused silica. For cooling, a cooling medium can be passed through the tube of transparent fused silica, thus preventing the tube from heating up to more than 140°C. The silica tube enclosing the radiation source may also be of double-walled design so that the cooling medium only flows between the two walls of the tube. It is true that a design such as this for an infrared lamp provides good cooling for the radiation source, which allows quite a high level of electrical power to be applied to the filament. However, because the radiation, on its path from the filament to an object to be irradiated, before reaching the object must always pass through the jacket of cooling medium, which acts as a filter, there is a not inconsiderable attenuation of the radiation.

It is an object of the invention to provide an infrared radiating member which is of simple construction, which can be produced in an economical fashion, which forms an easily exchanged component, and which allows a high level of electrical power to be applied to the heat-generating filament as a result of being vigorously cooled.

Accordingly the invention consists in a coolable infrared radiating member of the kind described wherein between 10% and 90% of the area of the wall of the tubular envelope for the filament is at the same time a part of the wall area of the cooling tube, and the cooling tube at no place completely surrounds the radiation source.

Advantageously, 25% to 75% of the area of the wall of the tubular envelope for the filament is at the same time a part of the wall of the cooling tube. By closing off one end of the cooling tube and inserting a means for dividing the stream of coolant, in the form of a plate or a tube for example, it is possible to arrange for the infeed and outfeed of coolant to take place at only one end of the infrared radiating member. Similarly, by for example inserting a plate or a tube in the tubular envelope for the filament, it is also possible to arrange the conductor in its tubular envelope in such a way that the electrical terminals are situated at only one end of the infrared radiating member. When the infrared radiating member is formed in this manner, namely with the coolant fed in and out at only one end of the cooling tube and the electrical terminals for the filament situated at only one end of the tubular envelope for the filament, then advantageously the infeed and outfeed of coolant is caused to take place at one end of the infrared radiating member and the electrical terminals for the filament are located at the opposite end. This physical separation between the electrical connecting area and the coolant infeed and outfeed area provides a high degree of safety in the operation of the infrared radiating member. To generate directional infrared radiation, it has proved advantageous to provide an appropriate part of the wall of the infrared radiating member with a reflective layer and preferably to gild it.

Infrared radiating members according to the invention can be used in many different applications. For example they may be fitted to copying apparatus, to devices for welding webs of plastics materials, in materials testing apparatus, and in installations for drying

filaments or metal wires covered with a layer of lacquer, to name only a few.

In order that the invention may be more clearly understood reference will now be made to the accompanying drawings which show some embodiments thereof by way of example and in which:—

Figure 1 is an elevational view of a partly cut-away infrared radiating member,

Figure 2 is cross-section through Figure 1 on line II–II,

Figure 3 is a partly cut-away elevational view of an infrared radiating member having a coolant connection at only one end and a current connection at only one end.

Figure 4 is a cross-section through Figure 3 on line II–IV,

Figure 5 is an elevational view of a multi-chamber infrared radiating member, partly in section on line IV–IV in Figure 6,

Figure 6 is a cross-section through Figure 5 on line VI–VI,

Figure 7 is a partly cut-away elevation view of a multi-chamber infrared radiating member, and

Figure 8 is a cross-section through figure 7 on line VIII–VIII,

Referring now to the drawings, as can be seen in Figure 1, the infrared radiating member consists of a tube 1 of transparent fused silica whose interior is divided by a wall 2 into two chambers 3 and 4. In chamber 3 is arranged an electrical heat-generating filament 5, which can be connected via terminals 6 and 7 to a source of electrical current. A part of the tube, namely the upper half-shell 1^{I} of the tube, and the wall 2 form a tubular envelope for the electrical filament 5. The chamber 4 has connections 8 and 9 at its two ends. The connection 8 may be connected to an infeed pipe for coolant, indicated by arrow 10. The connection 9 may be connected to an outfeed pipe for coolant, indicated by arrow 11. In the embodiment shown, the cooling tube is formed by the lower half-shell 1^{II} of the tube 1, and the wall 2, which latter at the same time forms a part of the wall of the tubular envelope for the filament.

The outer surface of the cooling tube is provided with a reflective layer 12, preferably a layer of gold. Instead of this, the side of the wall 2 remote from the filament 5 may be provided with a reflective layer. Should radiation in the opposite direction be required, then in place of reflective layer 12 a corresponding reflective layer is applied to the outer surface of the tubular envelope for the conductor.

The double-chamber or twin-tube infrared radiating member shown in Figure 1, may easily be produced by starting from a commercially available, drawn twin-tube made of transparent fused silica and arranging a filament 5 in one chamber and fusing connections 8, 9 for the infeed and outfeed of coolant to either end of the other chamber. It is however also possible to produce a double-chamber tube by inserting a strip of transparent fused silica into a tube of transparent fused silica and fusing it in conventional fashion to the tube along its longitudinal edges. After this the infrared radiating member is formed in the same way as was described above for a twin tube.

The filament 5 is supported by means of discs or plates 13 or similar mounting means which may consist of tantalum for example. The supply of electrical current to the filament takes place via terminals 6, 7 and the fused-in connections 16, 17.

In the case of the embodiment shown in Figures 1 and 2, the total wall-area of the tubular envelope for the filament is 2570 mm², which is made up of the wall area of the half-shell 1^{I} of the tube 1, $F_1 = 1570$ mm² and the area of the wall 2, $F_2 = 1000$ mm². This means that 38.9% of the total wall area of the tubular envelope for the filament is at the same time part of the wall of the cooling tube. The length of the tube in this case is 100 mm and the inside radius of the half-shell of the tube 5 mm.

The double-chamber infrared radiating member shown in figures 3 and 4 differs chiefly from that shown in figures 1 and 2 in that the electrical terminals 6, 7 for the filament 5 are provided at one end of the radiating member and the infeed and outfeed for coolant are moved to the opposite end. This lay-out is made possible by virtue of the fact a divider such a plate 19 is arranged in the chamber 3 and a divider such as a tube 20 is arranged in the chamber 4 and that in each case one end of the chamber is sealed off, being fused closed for example. These dividers 19, 20 are advantageously composed of the same material as the tube 1, i.e. transparent or opaque fused silica. The coolant then flows in through one part 4^{I} of the chamber and back through part 4^{II} of the chamber, as is indicated by arrows 21 and 22. The filament 5 is arranged iin the chamber 3 in the form of a U-loop.

Figures 5 and 6 show a multi-chamber infrared radiating member. The same reference numerals have been used for parts which are the same as in figures 1 and 2. The starting component is a tube 1 of transparent fused silica whose interior is divided into a plurality of chambers by a body 23 which has plate-like webs 24^{I}, 24^{II}, 24^{III}, 24^{IIII}, the chambers 3 being intended for the filament 5 and the chamber 4 for the coolant. The remaining chamber 24 is intended to receive or to have passed through it an article to be irradiated, such as a filament or lacquered wire to be dried. To make it easier to introduce the latter into the chamber 25, the chamber is provided with a slot 26. The body 23 is fused to the tube 1 at the longitudinal edges of the plate-like

webs.

In Figures 7 and 8 is shown another embodiment of multi-chamber infrared radiating member. In this case the body 27 which divides up the interior of the tube of transparent fused silica into chamber is in the shape of a double T in cross-section. The chambers 4 which are formed are intended for the passage of the coolant, the chamber 3 for the filament 5, and the chamber 25, which is provided with a slot 26, for the treatment of an article. This design with dual chambers for the coolant not only has the advantage that a high level of electrical power can be applied to the conductor as a result of the vigorous cooling but also that the infrared radiation reaches the treatment chamber 25 unattenuated.

The invention is not of course restricted to the embodiments shown. Thus, it is possible while still employing the concept of the invention to design infrared radiating members which have a plurality of tubular envelopes for heat-generating filaments and a plurality of cooling tubes, which may be arranged in any desired predeterminable manner and sequence.

WHAT WE CLAIM IS:—

1. A coolable infrared radiating member of the kind described wherein between 10% and 90% of the area of the wall of the tubular envelope for the filament is at the same time a part of the wall area of the cooling tube, and the cooling tube at no place completely surrounds the radiation source.

2. An infrared radiating member as claimed in claim 1, wherein 25% to 75% of the area of the wall of the tubular envelope for the filament is at the same time part of the wall area of the cooling tube.

3. An infrared radiating member as claimed in claim 1 or 2, wherein one end of the tubular envelope for the filament is sealed off, its interior is divided by a divider, and the electrical terminals for the filament are arranged at one end of the radiating member.

4. An infrared radiating member as claimed in claim 1 or 2, wherein one end of the cooling tube is sealed off, its interior is divided by a divider, and the connections for the infeed and outfeed of coolant are arranged at one end of the radiating member.

5. An infrared radiating member as claimed in claim 4, wherein the divider is a plate or a tube made of opaque or transparent fused silica.

6. An infrared radiating member as claimed in claims 3, 4 or 5, wherein the electrical terminals for the filament are arranged at one end of the radiating member and the connections for the infeed and outfeed of coolant are arranged at the opposite end of the radiating member.

7. An infrared radiating member as claimed in any of the preceding claims, which has a plurality of tubular envelopes for filaments each with one filament and/or a plurality of cooling tubes for the passage of coolant.

8. An infrared radiating member as claimed in claim 7, which has a chamber provided with a slot.

9. An infrared radiating member as claimed in any of the foregoing claims which is provided with a reflective layer.

10. An infrared radiating member as claimed in claim 9, wherein the reflective layer is of gold.

11. An infrared radiating member as claimed in claim 9 or 10, wherein the reflective layer is applied to the outer surface of the cooling tube, or to the outer surface of the tubular envelope for the filament, or to that surface of the common wall of the tubular envelope for the filament and the cooling tube which is remote from the filament.

12. An infrared radiating member substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

13. An infrared radiating member substantially as hereinbefore described with reference to Figures 3 and 4 of the accompanying drawings.

14. An infrared radiating member substantially as hereinbefore described with reference to Figures 5 and 6 of the accompanying drawings.

15. An infrared radiating member substantially as hereinbefore described with reference to Figures 7 and 8 of the accompanying drawings.

BARON & WARREN,
16, Kensington Square,
London, W8 5HL.
Chartered Patent Agents.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1978.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained

1531406 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

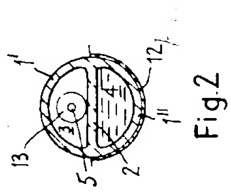

Fig.2

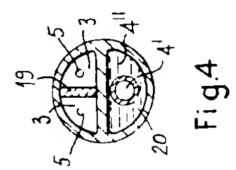

Fig.4

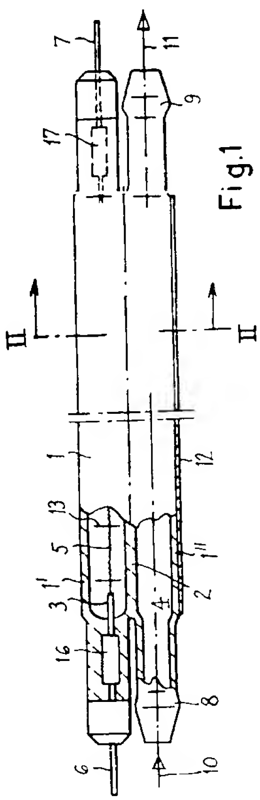

Fig.1

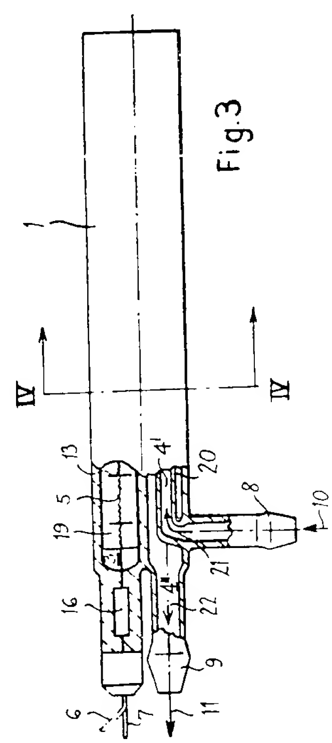

Fig.3

1531406 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

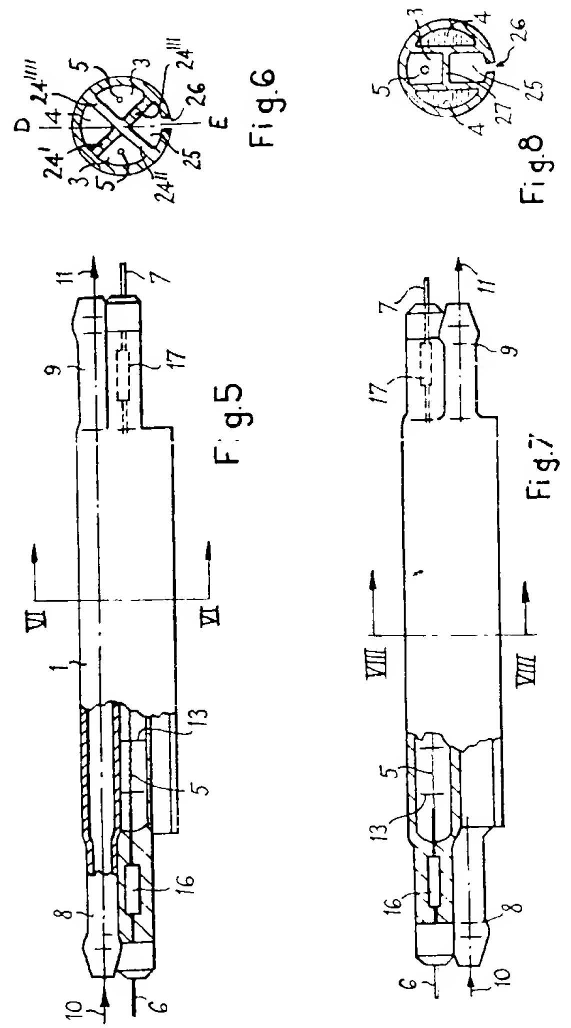

Fig.5

Fig.6

Fig.7

Fig.8